

AS 506 C/M 107 G&N 210  
L/M 5 G&N 609

# APOLLO 11 LUNAR LANDING



GUIDANCE  
NAVIGATION

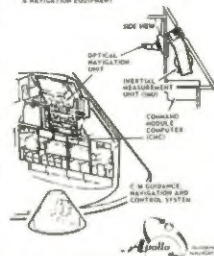
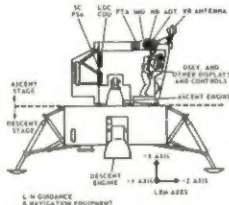


## LM GUIDANCE and NAVIGATION EQUIPMENT.....

### CM GUIDANCE, NAVIGATION and CONTROL SYSTEM

THE APOLLO GUIDANCE AND NAVIGATION SYSTEM IS COMPOSED OF THREE BASIC SUBSYSTEMS: INERTIAL, OPTICAL AND COMPUTER.

1. The inertial guidance subsystem is composed of inertial measurement unit (IMU) and associated equipment. This subsystem performs three major functions: (A) Measures changes in spacecraft attitude; (B) Measures spacecraft velocity due to thrust; and (C) Assists in generating steering signals.
2. The optical navigation subsystem is composed of a space sextant and a scanning telescope. Sightings on celestial bodies and landmarks on the moon and earth are used by the computer subsystem to determine the spacecraft's position and velocity and to align the inertial reference within the IMU.
3. The command module computer (CMC) provides five major functions: (A) Calculates steering signals and engine disretes necessary to keep the spacecraft on the required trajectory; (B) Positions the stable member in the IMU to a coordinate system defined by precise optical measurements; (C) Positions the optical unit to celestial objects; (D) Conducts limited malfunction isolation of the G&N system by monitoring the level and rate of system signals; and (E) Supplies pertinent spacecraft condition information to the display and control panel.



INERTIAL MEASUREMENT UNIT (IMU) and associated equipment performs three major functions; (A) Measures changes in LM attitude, (B) Assists in generating steering commands, and (C) Measures LM velocity changes due to thrust.

ALIGNMENT OPTICAL TELESCOPE (AOT) Provides star sighting data which is manually inserted into the LM Guidance Computer for establishing the inertial reference.

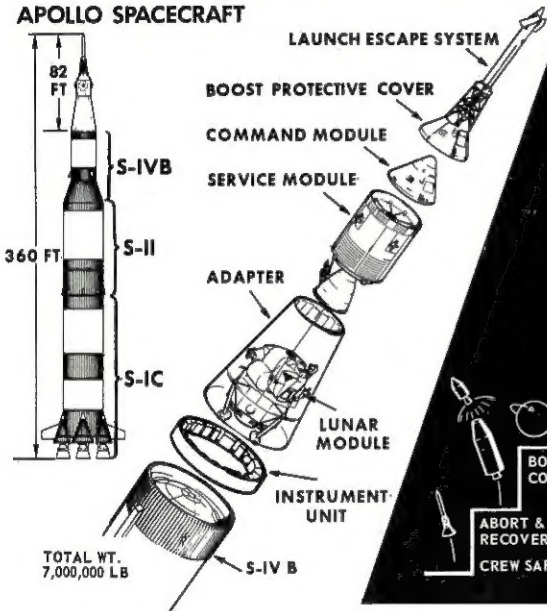
NAVIGATION BASE (NAV BASE) Provides an accurate mounting base for the Alignment Optical Telescope (AOT) and the Inertial Measurement Unit.

LM GUIDANCE COMPUTER (LGC) Performs four major functions: (A) Calculates steering signals and engine disretes necessary to keep the LM on the required trajectory, (B) Positions the stable member in the IMU to a coordinate system defined by precise optical measurements, (C) Conducts limited malfunction isolation of the PGNCs by monitoring the level and rate of system signals and (D) Supplies pertinent LM condition information to the display and control panels.

DISPLAY AND KEYBOARD (DSKY) Provides a two-way communication link between the operator and the LGC and the following functions may be performed: (A) Loading of data into the LGC and (B) Display of data and system configuration to the operator.

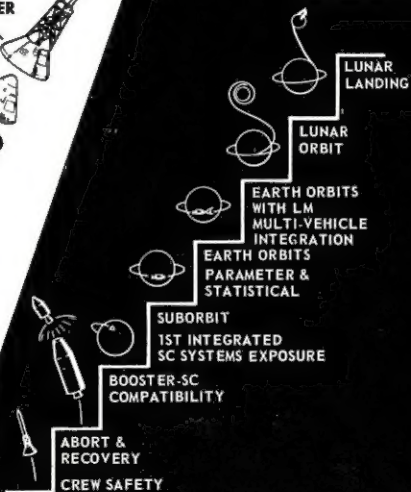
COUPLING DATA UNIT (CDU) The CDU, an all-electronic device, is used as an interface element between the following: (A) The inertial subsystem and computer subsystem and (B) The computer subsystem and the controls. This unit functions primarily as an analog to digital or digital to analog converter.

# APOLLO SPACECRAFT



## SPACECRAFT DEVELOPMENT FLIGHT CATEGORIES

### MAJOR STEPS TO ULTIMATE MISSION



- APOLLO-11 AS506 S/C107 LM5 LUNAR LANDING
- APOLLO-10 AS505 S/C106 LM4 LUNAR ORBIT W/LM (8 DAYS)
- APOLLO-9 AS504 S/C104 LM3 EARTH ORBIT W/LM (10 DAYS)
- APOLLO-8 AS503 S/C103 LUNAR ORBIT (6 DAYS)
- APOLLO-7 AS205 S/C101 EARTH ORBIT (10 DAYS)
- APOLLO-6 AS502 S/C020 EARTH ORBIT (3 REV)
- APOLLO-5 AS204 LM 1 EARTH ORBIT (4 REV)
- APOLLO-4 AS 501 S/C17 EARTH ORBIT (3 REV)
- AS 202 S/C11 SUBORBITAL
- SC 009 SUB-ORBITAL
- SC 002 TUMBLING ABORT
- BP 23A PAD ABORT
- BP 23 HI Q ABORT
- BP 22 HI ALTITUDE ABORT
- BP 15 BOOSTER
- BP 13 BOOSTER
- BP 12 TRANSONIC ABORT
- BP 6 PAD ABORT

# APOLLO 11 MISSION DESCRIPTION

## 1 Manned: Prime Crew

Neil A. Armstrong Commander (CDR)  
Michael Collins Command Module Pilot (CMP)  
Edwin E. Aldrin, Jr. Lunar Module Pilot (LMP)

## Back-up Crew

James A. Lovell (CDR)  
William A. Anders (CMP)  
Fred W. Haise, Jr. (LMP)

## 2. Fourth Manned Saturn V Mission

## 3. First Lunar Landing and Return Mission

## 4. Planned duration up to 11 days with Pacific Ocean Recovery

## 5. Booster Saturn V Booster #506

## 6. Spacecraft CSM #107 and Lunar Module #5

## 7 Block II G&N System #210 L/M G&N System #609



The nominal plan for Apollo 11 will provide for an EVA exploration period of open ended duration up to two (2) hours and 40 minutes. The planned lunar surface activities will include the following major items in order of priority:

## 1 Photographs of the landing area through LM Cabin Window

## 2. Contingency sample collection

## 3. EVA Evaluation

## 4. LM Inspection

## 5. Bulk sample collection

## 6. Deployment of early Apollo Scientific Experiment Payload (EASEP)

## 7 Documented sample collection

## 8. Television Transmission during the EVA period

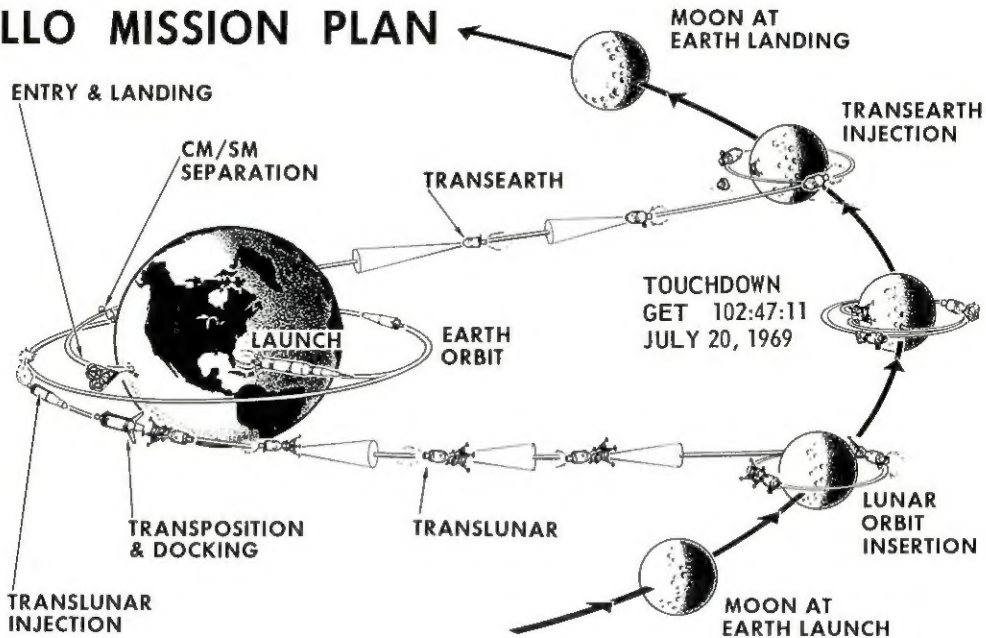
# SEQUENCE OF MAJOR EVENTS

EVENT	TIME <sup>o</sup> HR:MIN:SEC G.E.T.	DATA SUMMARY
EARTH ORBIT INSERTION	0:11:43	LATITUDE, DEG N 32.8 LONGITUDE, DEG W -54.2 INCLINATION, DEG 32.7
TRANSLUNAR INJECTION	2:44:26	BURN TIME, SEC 320.0 PLANE CHANGE, DEG -1.18
SPS EVASIVE MANEUVER	4:39:44	ALTITUDE, N. MI. 16 625.7 $\Delta V$ , FPS 19.7 BURN DURATION, SEC 2.9 PROPELLANT USED, LB 187.9
LUNAR ORBIT INSERTION	75:54:28	MASS AT IGNITION, LB 95 013.8 BURN TIME, SEC 359.0 PROPELLANT USED, LB 23 815.5 INCLINATION OF LPO, DEG 1.3 $\Delta V$ , FPS 2 924.4
LOI-2	80:09:29	MASS AT IGNITION, LB 71 148.9 BURN DURATION, SEC 16.4 PROPELLANT USED, LB 966.0 $\Delta V$ , FPS 157.8
LM SEPARATION (MINIFOOTBALL)	100:39	MASS AT IGNITION, LB 36 276.2 BURN TIME, SEC 8.0 PROPELLANT USED, LB 12.3 $\Delta V$ , FPS 2.5
DOI	101:38:48	IGNITION LONGITUDE, DEG -341.4 $\Delta V$ , FPS 71.4
PDI	102:35:13	BURN DURATION, SEC 28.6 IGNITION LONGITUDE, DEG 39.6 $\Delta V$ , FPS 6 766 BURN DURATION, SEC 718.0 PROPELLANT USED, LB 16 748.1
ASCENT	124:23:26	SUN ELEVATION AT SITE, DEG 9.85 PROPELLANT USED, LB 4 989.9 $\Delta V$ , FPS 6 060.0 BURN DURATION, SEC 438.0

EVENT	TIME <sup>o</sup> HR:MIN:SEC G.E.T.	DATA SUMMARY
LUNAR ORBIT PLANE CHANGE	125:50:28	MASS AT IGNITION, LB 36 24 BURN TIME, SEC PROPELLANT USED, LB 1 PLANE CHANGE, DEG 1 IGNITION LONGITUDE, DEG -14 $\Delta V$ , FPS 2
CSI	125:21:19	BURN DURATION, SEC 4 IGNITION LONGITUDE, DEG 1
CDH	126:19:37	$\Delta V$ , FPS BURN DURATION, SEC IGNITION LONGITUDE, DEG -1 $\Delta V$ , FPS 1
TPI	126:58:08	BURN DURATION, SEC IGNITION LONGITUDE, DEG -1 $\Delta V$ , FPS 1 BURN DURATION, SEC 1
DOCKING	128:00	
CSM SEPARATION MANEUVER FOLLOWING LM JETTISON	131:53:05	MASS AT IGNITION, LB 36 37 BURN TIME, SEC PROPELLANT USED, LB $\Delta V$ , FPS
TRANSEARTH INJECTION	135:24:34	MASS AT IGNITION 36 24 BURN TIME, SEC 14 PLANE CHANGE, DEG 4 PROPELLANT USED, LB 9 71 $\Delta V$ , FPS 321
ENTRY INTERFACE	195:03:27	VELOCITY, FPS 36 14 FLIGHT-PATH ANGLE, DEG 4 LATITUDE, DEG 1 LONGITUDE, DEG 17 TIME FROM TEI, HR:MIN 51 LATITUDE, DEG 10 LONGITUDE, DEG -17
SPLASHDOWN	195:17:22	

TIME REFERS TO G.E.T. OF IGNITION FOR BUR

# APOLLO MISSION PLAN





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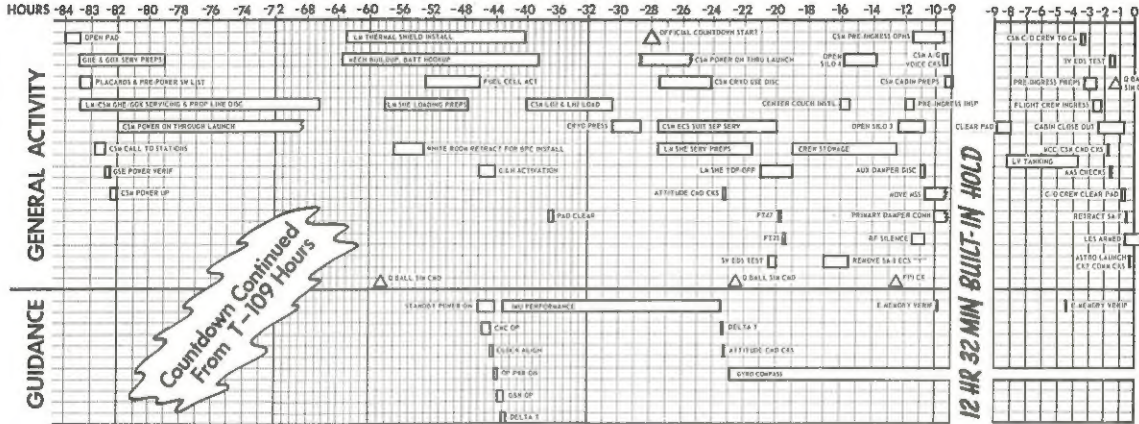
CSM  
(CMP)

LUNAR ORBIT SUMMARY FLIGHT PLAN																																																																																																						
ACTIVITY DAY	4 (LOI DAY)										5 (DOI EVA DAY)										6 (ASCENT TEI DAY)																																																																																	
EDT	1330	1530	1730	1930	2130	2330	0130	0330	0530	0730	0930	1130	1330	1530	1730	1930	2130	2330	0130	0330	0530	0730	0930	1130	1330	1530	1730	1930	2130	2330	0130																																																																							
GET	76	78	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132	134	136																																																																							
REV NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30																																																																								
LM (CDR LMP)	LMP IVT TO LM	ENTRY STATUS CHECKS	HOUSEKEEPING	COMM CHECKS	CLOSEOUT, IVT TO CSM	LMP IVT TO LM	LMP- PRIM GLYCOL	C&W CK	PGNCS ACTIVATION	CDR IVT TO LM	ECS ACTIVATION	S- AND CHECKS	SUIT IN/H2O SEP.	GLYCOL PUMP CKS	VHF ACTIVATION, CHECKOUT	LMP IVT TO CSM	DCI PGA IVT TO LM	IMU DOCKED COARSE	ALIGN	LMP CONNECT TO LM ECS	CDR ASSIST CMP, CLOSE AND	SECURE LM HATCH	ASCENT BATTERY ACT	AND CHECKOUT	DON HELMET & GLOVES, ARS/PGA	CHECKS	CABIN REGULATOR CHECK	DOFF HELMET & GLOVES	FINE ALIGN IMU	AIR ACTIVATION AND	SELF TEST	DEPLOY LANDING GEAR	INITIALIZE AGS	CS PRESSURIZE AND	CHECKOUT	ACT & SELF TEST	DPS PRESS AND	CHECKOUT	DON HELMET & GLOVES	UNDOCK	MNVR FOR INSPECTION	AGS UPDATE, ALIGN	RR, VHF RANGING CKS	AND LR SELF TEST	IMU REALIGN P52	DOI PREP	DOI	DOI PREP	POWERED DESCENT	TOUCHDOWN	POST TOUCHDOWN CHECKLIST	BEGIN SIMULATED COUNTDOWN	P57, GRAVITY MEASURE	P57, 2 CELESTIAL BODIES	P57, GRAVITY & 1 CELESTIAL BODY	END SIMULATED COUNTDOWN	EAT PERIOD	EAT PERIOD	SYSTEMS PREP FOR EGRESS	PREP FOR EGRESS	PLSS/OPS DOWNING	PLSS/EVCS ELECTRICAL CK	FINAL EVA EQUIP CK	FINAL SYSTEMS PREP	PREP FOR CABIN DEPRESS	PRESSURE INTEGRITY CK	2 hr 40 min EVA	POST EVA SYSTEMS CONFIG	PLSS/OPS DOFFING	FINAL SYSTEMS CONFIG	PREP FOR EQUIP JET	PRESSURE INTEGRITY CK	CABIN DEPRESS	HATCH OPENING	CABIN REPRESS	FINAL SYSTEMS CONFIG	POST EVA CABIN CONFIG	EAT PERIOD	AGS TURN ON, SELF TEST	P57, GRAVITY 1 CELESTIAL BODY	EAT PERIOD	VERIFY AGS	P57, GRAVITY CELESTIAL BODY	ASCENT PREP	INSERTION	RR SELF TEST	IMU REALIGN P52	RR TRACK OF CSM	CSI BURN RCS	PLANE CHANGE BURN - RCS	CDH BURN RCS	TPI BURN RCS	MCC1 BURN RCS	MCC2 BURN RCS	BRAKING BURNS RCS	DOCKING	TRANSFER & STOW EQUIP AND EQUIP	VACUUM & CLEAN SUITS	CDR TRANSFER TO CSM	LMP CONFIGURE LM FOR JETTISON	LMP IVT TO CSM	TEI

(CDR LM LMP)



# LAUNCH COUNTDOWN SC 107



# APOLLO 11 MISSION EVENTS (CSM)

G.E.T.	EVENT
HR:MIN:SEC	LAUNCH 0932 EDT 0832 CDT
11:43	EARTH ORBIT INSERTION
50:00	P52 REFS
1:32:00	UPDATE STATE VECTOR
2:12:00	GDC ALIGN TO IMU
2:44:26	TLI B.T. 5 MIN 20 SEC $\Delta V$ 10,451 FPS
2:52:00	P00 CMC IDLING
3:15:00	CSM/SIVB SEP
3:25:00	DOCKING
4:09:45	LM EJECTION BT 3.0 SEC
4:25:00	P40
4:39:45	EVASIVE MNVR B.T. 2.8 SEC $\Delta V$ 19.7 FPS
5:38:00	P52 REFS
6:00:00	P23 Cislunar NAV & OPTICS CAL.
10:10:00	UPDATE STATE VECTOR
10:43:00	P52 REFS
11:15:00	P40/41
11:45:00	MCC <sub>1</sub>
12:05:00	P52 PREF
24:18:00	P52 REFS
24:30:00	P23 Cislunar NAV
26:13:00	P40/41
26:45:00	MCC <sub>2</sub>
53:10:00	P52 REFS
53:27:00	P40/41
53:55:00	MCC <sub>3</sub>
56:15:00	LMP IVT TO LM
56:25:00	CDR IVT TO LM
57:40:00	LMP IVT TO CSM
57:53:00	CDR IVT TO CSM
68:32:00	STATE VECTOR UPDATE
70:10:10	P52 PREF
70:25:00	P40/41
70:55:00	MCC <sub>4</sub>

G.E.T.	EVENT
HR:MIN:SEC	
73:40:00	P52 REFS
74:05:00	MNVR TO BURN ATTITUDE
75:25:00	P40
75:54:28	LOI <sub>1</sub> B.T. 6 MIN $\Delta V$ 29.24 FPS 59.2 x 169.8 ORBIT
79:30:00	PIPA BIAS CHK.
79:33:00	MNVR TO LOI <sub>2</sub> BURN ATTITUDE
79:38:00	P40
80:09:30	LOI <sub>2</sub> B.T. 16.4 SEC $\Delta V$ 157.8 FPS (53.6 x 65.6 ORBIT)
81:20:00	P52 REFS
81:35:00	PREPARE FOR LM INGRESS
81:45:00	LMP IVT TO LM
82:25:00	P22
83:42:00	LMP IVT TO CSM
95:52:00	LMP IVT TO LM
96:53:00	CDR IVT TO LM
96:58:00	P52 PREF
98:35:00	P22
99:57:00	MNVR TO UNDOCK ATTITUDE
100:15:00	UNDOCK
100:31:00	P41
100:39:50	CSM/SEP B.T. 8 SEC $\Delta V$ 2.5 FPS (55.6 x 63.1 ORBIT)
100:49:00	P20
101:03:00	P52 REFS
101:30:00	P20 (SEXTANT TRACK LM)
102:32:00	P00 MANUAL ATTITUDE
103:36:00	P22
104:45:00	LM TRACKING
105:00:00	P52 PREF
106:58:00	P40
107:05:33	SPS, PLANE CHANGE
107:27:00	P52 PREF
114:35:00	VISUAL TRACKING LM (COAS)
124:10:00	MNVR TO SUPPORT LM/LO

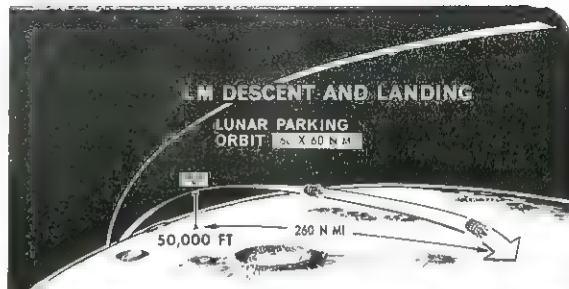
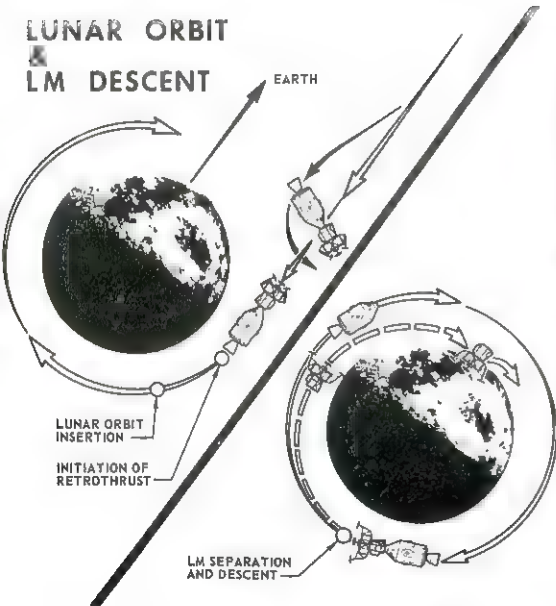
G.E.T	EVENT
HR:MIN:SEC	
124:40:00	P52 REFS
125:27:00	P20 (SEXTANT TRACK LM)
126:15:00	P41 CDH BACK-UP
128:00:00	DOCKING
130:05:00	CDR IVT TO CSM
130:43:00	LMP IVT TO CSM
131:53:05	LM JETTISON B.T. 3.1 SEC $\Delta V$ FPS (58.5 x 59.4 ORBIT)
132:00:00	MNVR TO TEI BURN ATTITUDE
134:42:00	P52 REFS
135:02	P40
135:24:34	TEI BT 2 MIN 29 SEC $\Delta V$ 3292.7 FPS
135:47:00	P52 PREF
136:00:00	P23 (5 SETS)
147:00:00	P23 (5 SETS)
149:25:00	P52 REFS
150:00:00	P40/41
150:24:00	MCC <sub>5</sub>
154:30:00	P23 (3 SETS)
158:00:00	P23 (5 SETS)
171:10:00	P52 REFS
171:32:00	P40/41
172:00:00	MCC <sub>6</sub>
191:08:00	P52 PREF
191:30:00	P40/41
192:06:00	MCC <sub>7</sub>
193:40:00	P52 REFS
194:20:00	P27
194:51:00	CM/SM SEP
195:03:27	E.I. 400K
195:10:41	GUIDANCE TERMINATION
195:11:39	DROGUE DEPLOY
195:12:27	MAIN DEPLOY
195:17:22	SPLASHDOWN

# APOLLO 11 MISSION EVENTS (LM)

G E T HR MIN SEC	EVENT
56 15 00	LMP IVT TO LM
56 25 00	CDR IVT TO LM (LM FAMILIARIZATION)
57 48:00	LMP IVT TO CSM
57 53 00	CDR IVT TO CSM
81 35 00	PREPARE FOR LM INGRESS
81.45:00	LMP IVT TO LM (HOUSEKEEPING CHORES)
83 42 00	LMP IVT TO CSM
95 52 00	LMP IVT TO LM
96 53 00	CDR IVT TO LM
96 55 00	PGNCS SELF TEST
97 18 00	E MEMORY DUMP
97 30 00	DOCKED IMU COARSE ALIGN
100:15 00	UNDOCK
100 39 50	CSM SEP
100 48 00	P27
101 22:00	P40 DPS THRUST
101 38 48	DPS DOI B.T. 28.5 SEC V 70 FPS (8.97 x 57.87 ORBIT)
102 05 00	P52 PITCH ALIGN CHK
102 25 00	LR ON
102 35:13	DPS - PDI B.T. 11 MIN 58 SEC V 6766 FPS
102:47 11	TOUCHDOWN
103 15 00	P57 IMU ALIGN REFS BEGIN SIMULATED COUNTDOWN
104 45 00	END SIM COUNTDOWN

G.E.T HR MIN:SEC	EVENT
110:40 00	PREPARE FOR EGRESS
112:45:00	CDR EGRESS TV TURN ON
113 10 00	LMP EGRESS
114 40 00	LMP EVA TERMINATION (INGRESS LM)
115:00:00	CDR EVA TERMINATION (INGRESS LM)
123 30 00	P57
124 23:26	APS LIFT OFF B.T. 7 MIN 18 SEC V 6060 FPS (60 KFT x 45 NM ORBIT)
124:30 44	ORBIT INSERTION
125 00 00	P20 (RENDEZVOUS NAV)
125:19 00	P41
125:21 19	RCS CSI B.T. 45 SEC V 49.5 FPS
125:44 00	P41
125 50 28	RCS PLANE CHANGE
126.13 00	P41
126 19 37	RCS CDH B.T. 1.9 SEC V 43 FPS
126:58 08	RCS - TPI B.T. 22.4 SEC V 24.8 FPS
127 13 08	RCS - MCC <sub>1</sub>
127 28 08	RCS - MCC <sub>2</sub>
127 36 00	RCS - BRAKING MNVR
128 00 00	DOCKING
130 05 00	CDR IVT TO CSM
130 43 00	LMP IVT TO CSM
131:53:05	LM JETTISON

# LUNAR ORBIT & LM DESCENT



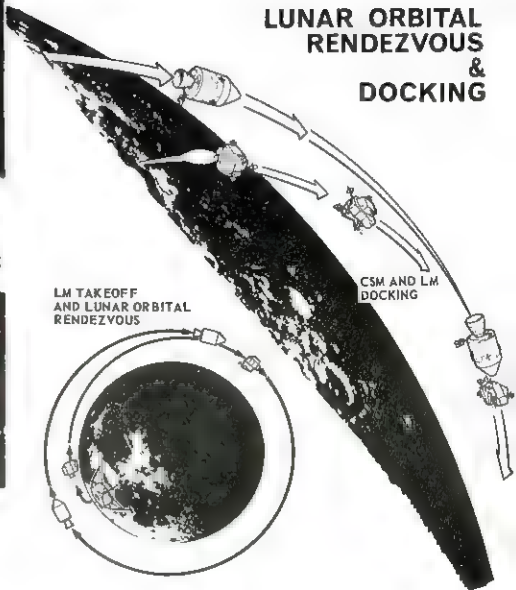
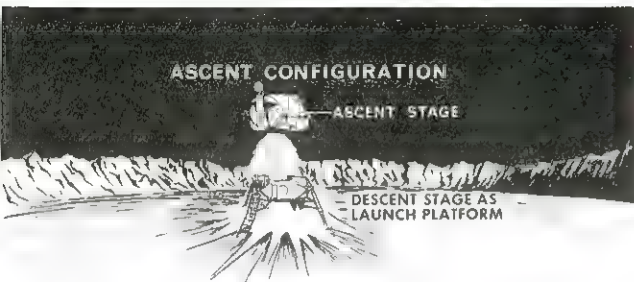
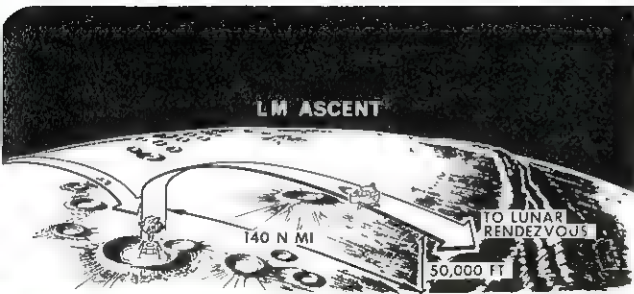
# SUMMARY OF LM DESCENT EVENTS

EVENT	TIME HR:MIN:SEC, G.E.T	PROPULSION SYSTEM	BURN TIME SEC	TOTAL $\Delta V$ FPS
CSM/LM UNDOCK	100:15:00	CM RCS	8.0	2.5
MSFN AOS	100:19:00			
CSM SEP	100:39:50			
MSFN LOS	101:30:00			
DOI	101:38:48			
MSFN AOS	102:19:00	LM DPS	28.5	70.0
POWERED DESCENT (PDI)	102:35:13			
FTP	102:36:13			
BEGIN LR ALTITUDE UPDATE	102:42:00			
DPS THROTTLE RECOVERY	102:43:00			
BEGIN LR VELOCITY UPDATE	102:44:00			
HIGH GATE	102:43:37			
ACQUIRE LANDING SITE VISIBILITY	102:43:41			
LOW GATE	102:45:21			
TOUCHDOWN	102:47:11			

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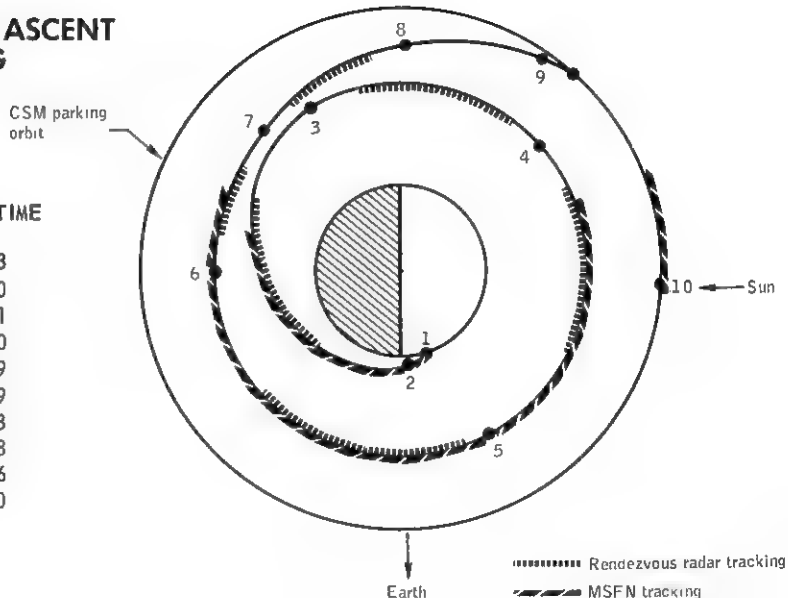
# LM ASCENT and RENDEZVOUS MANEUVER SUMMARY EVENTS

EVENT	TIME HR MIN SEC G E T	PROPULSION SYSTEM	RESULTANT			
			BURN TIME, SEC	TOTAL V FPS	PROPELLANT USED LB	ORBIT $h_a$ $h_p$ N.MI
LM LIFT-OFF	124 23 26	APS	0.0	0.0	0 0	
END VERTICAL RISE	124 23 36	APS	10.0	106.27	116 71	
LM INSERTION	124 30 44	APS	438 00	60.00	4989 86	
CSI	125 21 19	RCS Z (TWO-JET)	45.0	49 5	33 5	45 7 44.9
PC <sup>c</sup>	125 50 28	RCS Y (TWO-JET)	0 0	0 0	0 0	45 7 44 9
CDH	126 19 37	RCS X (FOUR JET)	1 9	4.3	4.1	45 3 43 8
TPI	126 58 08	RCS Z (TWO-JET)	22 4	24.8	17 1	61 7 43 3
MC-1 <sup>c</sup>	127 13 08	RCS Z (TWO-JET)	0 0	0 0	0 0	62 6 43 8
MC-2 <sup>c</sup>	127 28 08	RCS Z (TWO-JET)	0 0	0 0	0 0	62.6 43.8
FIRST BRAKING MANEUVER	127 36 57	RCS Z (TWO-JET)	10.8	12.0	7.6	60 7 49 0
SECOND BRAKING MANEUVER	127 39 24	RCS Z (TWO-JET)	8 8	9 8	6 5	60 3 53 7
THIRD BRAKING MANEUVER	127 40 33	RCS Z (TWO-JET)	4 3	4 8	3 2	60 1 56 2
FOURTH BRAKING MANEUVER	127 42 16	RCS Z (TWO-JET)	4.2	4 7	3 1	58 9 59 9
DOCKING	128 00 00					60 9 59 1

# ORBITAL SCHEMATIC ASCENT THROUGH DOCKING

EVENT	G.E.T TIME
1 LIFT-OFF	124:23
2. LM INSERTION	124:30
3. CSI	125:21
4. PC	125:50
5. CDH	126:19
6. TPI	126:19
7. MCI	127:13
8. MC2	127:28
9 BEGIN BRAKING	127:36
10. DOCKING	128:00

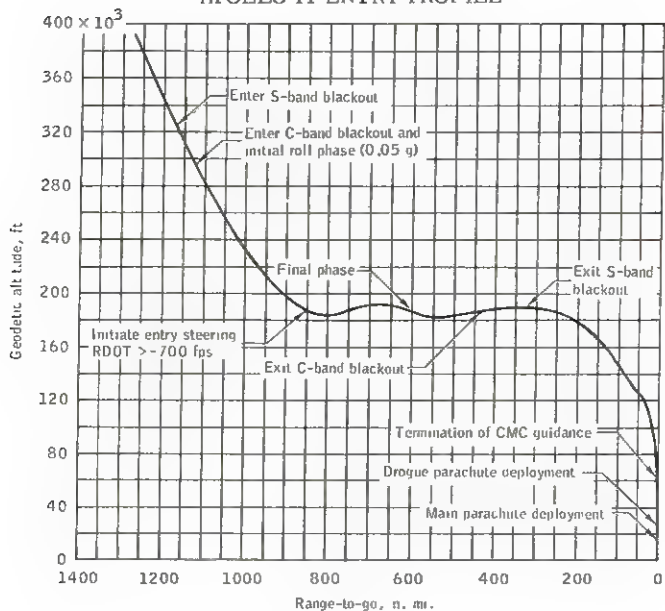
TEI GET 135:24:34



## ENTRY EVENTS SEQUENCE

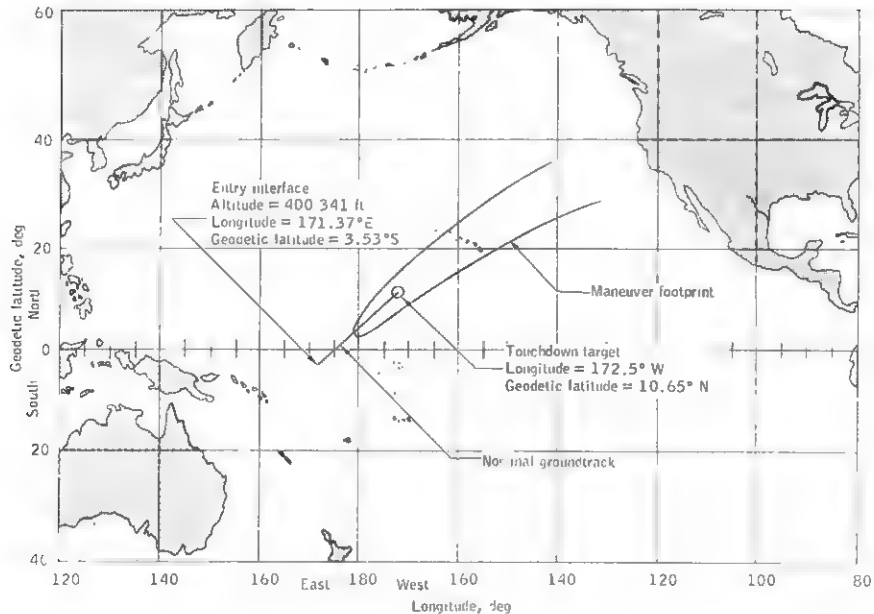
EVENT	TIME FROM 400 000 FT MIN:SEC
ENTRY	0:00
ENTER S-BAND COMMUNICATION BLACKOUT	:19
ENTER C-BAND COMMUNICATION BLACKOUT	:29
LOAD FACTOR = 0.05g	
MAXIMUM HEATING RATE	1:09
GUIDANCE INITIATE AT R-DOT = -700 FPS	1:17
MAXIMUM LOAD FACTOR (FIRST)	1:21
EXIT C-BAND COMMUNICATION BLACKOUT	3:01
EXIT S-BAND COMMUNICATION BLACKOUT	3:37
MAXIMUM LOAD FACTOR (SECOND)	5:23
TERMINATION OF CMC GUIDANCE	7:11
DROGUES PARACHUTE DEPLOYMENT	8:13
MAIN PARACHUTES DEPLOYMENT	9:00
SPLASHDOWN	13:57

# APOLLO 11 ENTRY PROFILE



GEODETIC ALTITUDE VERSUS RANGE-TO-GO





MANEUVER FOOTPRINT AND NOMINAL GROUNDTRACK

# NOUN 70 CODES

R1: CELESTIAL BODY CODE 000XX

00 PLANET	27 ALKAID
01 ALPHERATZ	30 MENKENT
02 DIPHDA	31 ARCTURUS
03 NAVI	32 ALPHECCA
04 ACHERNAR	33 ANTARES
05 POLARIS	34 ATRIA
06 ACAMAR	35 RASALHAGUE
07 MENKAR	36 VEGA
10 MIRFAK	37 NUNKI
11 ALDEBARAN	40 ALTAIR
12 RIGEL	
13 CAPELLA	
14 CANOPUS	
15 SIRIUS	
16 PROCYON	
17 REGOR	41 DABIH
20 DNOCES	42 PEACOCK
21 ALPHARD	43 DENEK
22 REGULUS	44 ENIF
23 DENEbola	45 FOMALHAUT
24 GIENAH	46 SUN
25 ACRUX	47 EARTH
26 SPICA	50 MOON

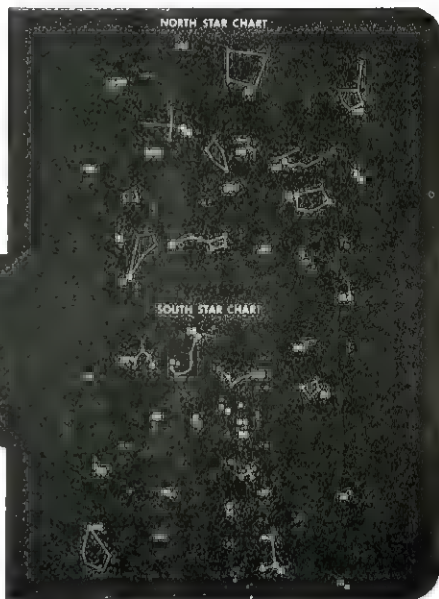
R2: LANDMARK DATA ABCDE

A = 1 IF KNOWN LDMK  
 A = 2 IF UNKNOWN LDMK  
 B = INDEX OF OFFSET DESIG  
 C = NOT USED  
 DE = LDMK ID NO



R3: HORIZON DATA 00CDO

C = 1 FOR EARTH HORIZON  
 C = 2 FOR MOON HORIZON  
 D = 1 FOR NEAR HORIZON  
 D = 2 FOR FAR HORIZON



## CHECKLIST REF CODES (V50N25)

R1 CODE	ACTION
00013	PERFORM COARSE ALIGN
00014	PERFORM FINE ALIGN
00015	ACQUIRE CELESTIAL BODY
00016	TERMINATE MARKS
00041	CM/SM SEP
00062	KEY CMC TO STBY
00202	G&N AUTO MNVR
00204	SPS GMBL TRIM

## ALARM CODES (V05N09)

CODE	DESCRIPTION	CORRECTIVE ACTION
00110	MARK REJECT UNNECESSARY	RSET/CONT
00112	MARK NOT ACCEPTED	RSET/CONT
00113	NO INBITS	RSET/REATTEMPT ENTRY
00114	MARK NOT DESIRED	RSET/CONT
00115	TOR REQ-OSS NOT IN CMC	SET OSS TO CMC/RSET/CONT
00116	OSS SW BEFORE 15 SEC	SET OSS TO ZERO/RSET/CONT
00117	TOR REQ-OSS NOT AVAIL	RSET
00120	TOR REQ-OSS NOT ZEROED	SET OSS TO ZERO/RSET/CONT
00121	CDUS NO GO AT MARK	RSET/REPEAT MARK
00122	MARKING NOT CALLED FOR	RSET/CONT
00124	NO SOLUTION TO TPI	RSET/V32E
00205	PIPA SATURATED	RSET/SWITCH TO SCS
00206	ZERO ENCODE NOT ALLOWED	RSET/V41/V40
00211	COARSE ALIGN ERROR	RSET/REPEAT AND/OR FA CK
00217	ISS MODE SWITCH FAIL	RSET/REINITIATE PROG, CONT

00220	IMU NOT ALIGNED	RSET/P51 OR SET FLAG
00401	DESIRED ANGLES GMBL LOCK	RSET/AVOID GMBL LOCK
00404*	TARGET OUT OF 90 DEG	RSET/MNVR NEW TGT
00405	TWO STARS NOT AVAIL	MNVR/RSET/V32E/NEW STAR
00406	P20 NOT OPERATING	RSET
00407	TARGET OUT OF 50 DEG	RSET/MNVR
00421	W MATRIX OVERFLOW	RSET/NOTIFY MSFN, CONT
00430**	ACC OVERFLOW IN INTEG	RSET/REINITIATE PROG
00600	IMAG ROOTS FIRST ITER	
00601	HP POST CSI LOW	
00602	HP POST CDH LOW	
00603	TIG CSI-CDH<10 MIN	
00604	TIG CDH-TPI<10 MIN	
00605	ITER>LOOP MAX	
00606	ΔV EXCEEDS MAX	
00607**	NO SOL TIME 0 OR R	
00611	NO TIG FOR ELEV ANGLE	
01105	DOWN TEL TOO FAST	
01106	UP TEL TOO FAST	
01207*	NO VAC AREA FOR MARKS	
01211*	ILLEGAL RUPT OF EXT D VERB	
01302**	NO SOLUTION	
01407	VG INCREASING	
01426	IMU UNSAT	
01427	IMU REVERSED	
01520	V37 NOT ALLOWED	
01521**	P01 ILLEG SELECT	
01703	CANNOT INTEG SV TO TIG	

RSET/V32E ADJUST  
INPUT PARAMETERS

RSET/REINITIATE PROG  
PRO NEW ELEV/RSET  
RSET  
RSET/RETRANSMIT  
RSET/TERM REINITIATE P51/P52  
RSET/TERM REINITIATE PROG  
RSET/NOB, NOTIFY MSFN, CONT  
TERMINATE THRUST/RSET  
RSET/REALGN IMU  
RSET/CONT/0 DEG = LIFT DN  
RSET/RESELECT V37  
RSET/REINITIATE PROG  
RSET/AUTO TIG SLIP

# AUTO DISPLAY \* RESTART \*\* POODOO

# C/M COMPUTER PROGRAMS

PHASE	PROGRAM NUMBER	PROGRAM TITLE
PRE-LAUNCH AND SERVICE	00	CMC Idling
	01	Prelaunch or Service-Initialization
	02	Prelaunch or Service-Gyro Compassing
	03	Prelaunch or Service-Optical Verification of Gyro Compassing
	06	GNCS Power Down
	07	Systems Test
	11	Earth Orbit Insertion Monitor (EOI)
BOOST	17	Transfer Phase Initialization Search (TPI)
COAST	20	Rendezvous Navigation
	21	Ground Track Determination
	22	Orbital Navigation
	23	Cislunar Midcourse Navigation
PRE- THRUSTING	27	CMC Update
	30	External Delta V
	31	Lambert Aimpoint Maneuver
	32	Co-elliptic Sequence Initiation (CSI)
	33	Constant Delta Altitude (CDH)
	34	Transfer Phase Initiation (TPI)
	35	Transfer Phase (Midcourse)
	37	Return to Earth (RTE)
	38	Stable Orbit Rendezvous (SOR)
	39	Stable Orbit Midcourse (SOM)
THRUSTING	40	SPS
	41	RCS
	47	Thrust Monitor
ALIGNMENT	51	IMU Orientation Determination
	52	IMU Realign
	53	Back-up IMU Orientation Determination
	54	Back-up IMU Realign
ENTRY	61	Entry-Maneuver to CM/SM Separation Attitude
	62	Entry-CM/SM Separation and Pre-entry Maneuver
	63	Entry Initialization
	64	Entry-Post 0.05G
	65	Entry-UP Control
	66	Entry-Ballistic
	67	Entry-Final Phase
ABORT	72	LM Co-Elliptic Sequence Initiation (CSI) Targeting
	73	LM Constant Delta Altitude (CDH) Targeting
	74	LM Transfer Phase Initiation (TPI) Targeting
	75	LM Transfer Phase (MIDCOURSE) Targeting
	76	LM Target Delta V
	77	LM TPI Search
	78	LM SOR Targeting
	79	LM SOM Targeting

# L/M COMPUTER PROGRAMS

NUMBER	TITLE
● SERVICE	
P00	LGC Idling
P06	PGNCS Power
P07	Systems Test (Non-flight)
● ASCENT	
P12	Powered Ascent Guidance
● COAST	
P20	Rendezvous Navigation
P21	Ground Track Determination
P22	RR Lunar Surface Navigation
P25	Preferred Tracking Attitude
P27	LGC Update
● PRETHRUSTING	
P30	External Delta V
P31	Lambert Aimpoint Guidance
P32	Co-elliptic Sequence Initiation (CSI)
P33	Constant Delta Altitude (CDH)
P34	Transfer Phase Initiation (TPI)
P35	Transfer Phase Midcourse (TPM)
P38	Stable Orbit Rendezvous (SOR)
P39	Stable Orbit Midcourse (SOM)
● THRUST	
P40	DPS Thrusting
P41	RCS Thrusting
P42	APS Thrusting
P47	Thrust Monitor
● ALIGNMENTS	
P51	IMU Orientation Determination
P52	IMU Realign
P57	Lunar Surface Alignment
● DESCENT & LANDING	
P63	Landing Maneuver Braking Phase
P64	Landing Maneuver: Approach Phase
P65	Landing Phase (Auto)
P66	Rate of descent Landing (ROD)
P67	Landing Phase (Manual)
P68	Landing Confirmation
● ABORTS AND BACKUPS	
P70	DPS Abort
P71	APS Abort
P72	CSM Co-elliptic Sequence Initiation (CSI) Targeting
P73	CSM Constant Delta Altitude (CDH) Targeting
P74	CSM Transfer Phase Initiation (TPI) Targeting
P75	CSM Transfer Phase Midcourse (TPM) Targeting
P76	Target Delta V
P78	CSM Stable Orbit Rendezvous (SOR) Targeting
P79	CSM Stable Orbit Midcourse (SOM) Targeting



# ABBREVIATIONS

ACN	ASCENSION TRACKING STATION
AGS	ABORT GUIDANCE SYSTEM
ANG	ANTIGUA TRACKING STATION
AOS	ACQUISITION OF SIGNAL
APS	ASCENT PROPULSION SYSTEM
BDA	BERMUDA TRACKING STATION
BT	BURN TIME
CAL	CALIFORNIA TRACKING STATION
CDH	CONSTANT DIFFERENTIAL HEIGHT
CDR	COMMANDER
CES	CONTROL ELECTRONICS SYSTEM
CMC	COMMAND MODULE COMPUTER
CRO	CARNARVON TRACKING STATION
CSI	CONCENTRIC SEQUENCE INITIATION
CSM	COMMAND AND SERVICE MODULES
CYI	GRAND CANARY ISLAND
DAP	DIGITAL AUTOPILOT
DOI	DESCENT ORBIT INSERTION
DPS	DESCENT PROPULSION SYSTEM
EI	ENTRY INTERFACE
EMU	EXTRAVEHICULAR MOBILITY UNIT
EOI	EARTH ORBIT INSERTION
EPO	EARTH PARKING ORBIT
EVA	EXTRAVEHICULAR ACTIVITY
EVT	EXTRAVEHICULAR TRANSFER
FTP	FIXED THROTTLE POINT
GBM	GRAND BAHAMA TRACKING STATION
GDS	GOLDSTONE TRACKING STATION
g. e. t.	GROUND ELAPSED TIME
G. m. t.	GREENWICH MEAN TIME
G&N	GUIDANCE AND NAVIGATION
GYM	GUAYMAS TRACKING STATION
H <sub>a</sub>	APOGEE ALTITUDE
HAW	HAWAII TRACKING STATION
H <sub>p</sub>	PERIGEE ALTITUDE
IVC	INTERVEHICLE COMMUNICATIONS
IVT	INTRAVEHICULAR TRANSFER
LGC	LM GUIDANCE COMPUTER
LM	LUNAR MODULE
LMP	LUNAR MODULE PILOT
LOI	LUNAR ORBIT INSERTION
LOS	LOSS OF SIGNAL

# ABBREVIATIONS

LPO	LUNAR PARKING ORBIT
LR	LANDING RADAR
MC	LM MIDCOURSE CORRECTION
MCC	MIDCOURSE CORRECTION
MER	MERCURY TRACKING SHIP
MGA	MIDDLE GIMBAL ANGLE
MIL	MERRITT ISLAND TRACKING STATION
MSFN	MANNED SPACE FLIGHT NETWORK
OGA	OUTER GIMBAL ANGLE
OPS	OXYGEN PURGE SYSTEM
PC	PLANE CHANGE
PDI	POWER DESCENT INITIATION
PGA	PRESSURE GARMENT ASSEMBLY
PGNCS	PRIMARY GUIDANCE & NAVIGATION CONTROL SUBSYSTEM
PLSS	PORTABLE LIFE SUPPORT SYSTEM
PRE	PRETORIA TRACKING STATION
PTC	PASSIVE THERMO CONTROL
RCS	REACTION CONTROL SUBSYSTEM
RDG	POSITION TARGET FOR LM DESCENT
RR	RENDEZVOUS RADAR
SECO	SIVB ENGINE CUT-OFF
SLA	SPACECRAFT LM ADAPTER
SPS	SERVICE PROPULSION SYSTEM
S-IC	SATURN IC, LV FIRST STAGE
S-II	SATURN II, LV SECOND STAGE
S-IVB	SATURN IVB, LV THIRD STAGE
TAN	TANANARIVE TRACKING STATION
TEC	TRANSEARTH COAST
T&D	TRANSPOSITION & DOCKING
TEI	TRANSEARTH INSERTION
TEX	CORPUS CHRISTI TRACKING STATION
TLC	TRANSLUNAR COAST
TLI	TRANSLUNAR INJECTION
TPF	TERMINAL PHASE FINALIZATION
TPI	TERMINAL PHASE INITIALIZATION
TPM	TERMINAL PHASE MIDCOURSE
TVC	THRUST VECTOR CONTROL
VAN	VANGUARD TRACKING SHIP
ΔV	VELOCITY CHANGE (DIFFERENTIAL)
ΔVC	VELOCITY CHANGE AT ENGINE CUT-OFF
ΔR	POSITION CHANGE (DIFFERENTIAL)

# SATURN V SECOND STAGE (S-II-6) FACT SHEET

The Saturn V launch vehicle's second stage to be used in Apollo 11's manned lunar landing mission is the sixth in a series of S-II stages.

## S-II-6 STATISTICAL SUMMARY

Height	81 feet 6 inches
Diameter	33 feet
Weight (pounds) *	
Dry	79,918
Liftoff (ground)	1,069,274
Burnout	94,140
Propellant Loading (total)	979,243
LH <sub>2</sub>	158,221
LOX	821,022
Power	
Engines (five J-2s) built by Rocketdyne, a division of North American Rockwell)	
Thrust (pounds)	230,000 per engine at 5.5 to 1 oxygen/hydrogen mixture ratio
Ullage motors (4)	Thrust (pounds) 22,700 per motor
Burntime	6 minutes, 29 seconds
Velocity	
S-IC/S-II-6 separation	9,064 feet per second (air speed, includes the earth's rotation)
S-II-6/S-IVB separation	22,757 feet per second
Altitude	
S-IC/S-II-6 separation	219,984 feet
S-II-6/S-IVB separation	609,982

## SEQUENCE OF S-II-6 APOLLO 11 MISSION EVENTS

Normal flight time (minutes: seconds)	
2:40.8	S-II LH <sub>2</sub> recirculation stop
2:41.3	S-II ullage motor trigger
2:41.6	S-IC/S-II separation
2:43.2	S-II engine start
3:11.9	S-IC/S-II aft interstage separation
4:21.1	S-II LOX step pressurization
7:39.8	S-II center engine cutoff
7:40.6	S-II LH <sub>2</sub> step pressurization
9:11.4	S-II outboard engines cutoff
9:12.2	S-II/S-IVB separation
20:16	S-II Atlantic splashdown (2,300 nautical miles downrange)

\*Weights, times, velocities, altitudes estimates

# **APOLLO 11**

## **SPACECRAFT WEIGHTS**

(CSM 107 & LM 5)

Command module (including propellants & fluids)	12,253 lb
Service module (including propellants & fluids)	51,156
Spacecraft lunar module adapter (SLA)	4,049
Lunar module LM-5	33,277
Launch escape system	8,910
Total spacecraft weight at launch	109,645 lb
Spacecraft weight injected into earth orbit	100,735 lb (spacecraft with launch escape system jettisoned)
Command module weight at splashdown (normal mission)	10,971 lb (with para- chutes disconnected)

## **APOLLO 11**

### **SPACECRAFT WEIGHT BREAKDOWN**

Command module (less RCS propellants)	12,007 lb
Reaction control system propellants	246
Service module (empty)	8,324
Service propulsion system propellants	40,803
Reaction control system propellants	1,341
Cryogenics (hydrogen & oxygen)	688
Total weight of spacecraft command and service modules	63,409



**Space Division**  
North American Rockwell

Public Relations Department  
12214 Lakewood Boulevard  
Downey, California 90241  
(213)923-8111 ext 6467, 6460, and 6468